WIRELESS MUSIC SYSTEM

BACKGROUND OF THE INVENTION

TECHNICAL FIELD

The invention relates generally to wireless headphones and speakers and, more particularly, is directed to wireless headphones and speakers in which a satisfactory receiving condition is always maintained regardless of the condition and position.

DESCRIPTION OF THE PRIOR ART

A wireless headphone system has recently been developed, in which a signal is transmitted through infrared rays from a transmitter and received at a remote position from the transmitter, so a listener can enjoy music.

Japanese Laid-Open Patent Gazette No. 55-82596 describes a wireless headphone using infrared rays. This headphone is a wireless-type headphone, so that the usable range the user uses the headphone is not limited by a headphone cord. Further, using infrared rays prevents the

wireless headphone from interfering with other radio waves. An infrared signal transmitted from a transmitter is received by a light-receiving element provided on a top portion, of a headband portion, of the wireless headphone. A signal outputted from the light-receiving element is supplied through an amplifier. A demodulating circuit and a reproducing circuit are powered by a power supply source such as a battery incorporated within the headphone. The receive signal is demodulated and reproduced in the headphone unit portion.

Abe, *Wireless Headphones,* U.S. Patent No. 5,095,382, March 10, 1992 teaches the use of multiple receivers on the headphones. This is done to increase the number of locations where the transmitted signal is received. This also reduces the likelihood that the signal is not received.

The problem with these solutions is that they focus only on improving the receiver, not the transmitter. Irrespective of how many receivers are put on a pair of headphones, it still does not receive a signal if there is no signal at that location. Multiple transmitters can be used to increase coverage, but this results in greatly increased costs and occupies more space. What is needed

is a solution that improves the coverage of an infrared transmitter without greatly increasing the cost or space used.

Similarly, wireless speakers receive a transmitted infrared signal from a transmitter. The problem with current solutions is they take time to setup because most transmitters have limited coverage. Much time must be taken to properly place the speakers, and to ensure that they can receive the signal. What is need is a method to improve infrared signal coverage.

SUMMARY OF THE INVENTION

A method and apparatus is disclosed which provides for a wireless method to transmit a signal from a stereo to wireless headphones or speakers. Typically the signal is analog, but the signal may also contain data. An infrared beam transmitter diverges its signal by passing through a concave lens. The divergent beam has a wider range than a non-divergent signal. The beam is designed to bounce off of walls, ceilings and floors before reaching the receiver on the headphones/speakers. This way, a person wearing headphones can move about the coverage area without losing the signal, or

speakers may be placed anywhere in a room, without worry that the signal is not received.

The receiver may also have a convex lens affixed to it so as to converge the transmitted signal. The convex lens focuses the signal so that transmitter can better interpret it. The signal may also be polarized so that the receiver filters out ambient light. Ambient light causes signal noise. Thus, filtering out the noise increases signal to noise ratio.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram illustrating a pair of headphones and a transmitter according to the invention;

Figure 2 is a diagram illustrating a transmitter with a concave lens according to the invention;

Figure 3 is a diagram illustrating a receiver with a concave and convex lens according to the invention;

Figure 4 is a diagram illustrating a transmitter with a polarizer according to the invention;

Figure 5 is a diagram illustrating a receiver with a polarizer according to the invention;

Figure 6 is diagram illustrating linearly polarized light according to the invention;

Figures 7A and 7B are diagrams illustrating linearly polarized light over an angular range according to the invention;

Figure 8 is a diagram illustrating the light spectrum,

Figures 9A, 9B and 9C are diagrams illustrating a counter-weighted receiver according to the invention;

Figures 10A, 10B and 10C are diagrams illustrating a reflective signal according to the invention; and

Figure 11 is a diagram illustrating a parabolic deflector according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a wireless headphone system according to an embodiment of the present invention, which comprises a transmitter 1 and a wireless headphone 2. A transmitted infra-red light signal transmitted from the transmitter 1 is received by the wireless headphone 2 which in turn, reproduces an audio signal from the received light signal and supplies the same to unit portions 11 and 12 so as to be heard by the listener. The wireless headphone is powered by a battery.

As shown in FIG. 1, the transmitter 1 is generally comprised of a transmitter body 3 and a leg or base 4 that supports the transmitter body 3. An audio signal is supplied to the transmitter from an audio apparatus through an input cable (not shown), whereupon the audio signal is converted to a modulated infrared transmission light signal, which is transmitted from a light-transmitting portion 5 of the transmitter 1. The transmitter body 3 is adapted to be

rotatable, relative to the base 4, so as to vary the direction in which the transmission light signal is transmitted.

As shown in Figure 1, the wireless headphone 2 is generally comprised of a headband portion 8 and a pair of headphone unit portions 11 and 12, which are supported by the two end portions of the head band portion 8 through hanger portions 9 and 10, respectively. The headphone unit portions 11 and 12 each incorporate speakers therein (not shown). Dial 14 is used to adjust the sound volume.

Wireless headphone 2 is provided with light receiving portions 16, 17 and 18 at three portions of headphone 2, that is, the central top portion or top portion of the head band portion 8 and the front side portions of the left and right headphone unit portions 11 and 12. The light receiving portions 16, 17 and 18 are covered with filter caps 16a, 17a and 18a, respectively which, in a preferred embodiment, are pervious only to infrared signals.

The light-receiving portion 16 is provided on the top portion of the headband portion 8. The received transmitted light signal is demodulated to provide an

audio signal, which is reproduced by the headphone unit portions 11 and 12 as an audio sound.

The wireless headphone system receives a transmitted light signal, even when the listener wearing the headphone turns his or her head in any direction. That is, one of the three light receiving portions 16, 17 and 18 receives the transmitted light signal. The wireless headphones include electronic circuits that may include an amplifying circuit. A circuit board is located within a filter cap for supporting a light-receiving element.

Three light receiving portions 16, 17 and 18 are provided on the top portion of the headband portion 8 and on the respective headphone unit portions 11 and 12, as previously described. As a result, even when one of the light receiving portions is hidden by the listener's hair, other light receiving portions receive the transmitted light signal from the transmitter 1.

Figure 2 illustrates a preferred embodiment of the transmitter 200. In this embodiment, a light-emitting element 210 emits an infrared signal 220. The signal is diverged through a plano-concave lens 230. The effect of a divergent

signal 240 is a signal that has a wider swath than a non-divergent signal 220, and thus there is more area covered by the signal. Typically the lens 230 is constructed of glass, plastic or other material with similar refractive qualities.

Figure 3 illustrates a receiver 300 according to a preferred embodiment. A plano-concave lens 310 is placed so as to first receive incoming infrared signals 240. The plano-concave lens 310 is placed so as to converge the incoming signal 240 and produce a signal that has a substantially straight pattern 320. The plano-concave lens 310 can receive signals at high incident angles. After the signal passes through the plano-concave lens, it passes through a plano-convex lens 330. The plano-convex lens converges the signal onto the receiver potion 340.

Figures 4 and 5 illustrate another embodiment where the signal is transmitted through a linear polarizer 410 at the transmitter 210, and received through a similarly orientated linear polarizer 510 at the receiver. Light can be represented as a transverse electromagnetic wave made up of mutually perpendicular, fluctuating electric and magnetic fields. The light has an electric field and a magnetic field each lying in perpendicular planes, propagating in the same direction.

The sinusoidally varying electric field can be thought of as a length of rope held by two children at opposite ends. The children begin to displace the ends in such a way that the rope moves in a plane, either up and down, left and right, or at any angle in between.

Ordinary white light is made up of waves that fluctuate at all possible angles. Light is considered to be linearly polarized when it contains waves that only fluctuate in one specific plane. It is as if the rope is strung through a picket fence -- the wave can move up and down, but motion is blocked in any other direction. A polarizer is a material that allows only light with a specific angle of vibration to pass through. The direction of fluctuation passed by the polarizer is called the easy axis.

Linear polarization is merely a special case of circularly polarized light. In Figure 6, consider two light waves, one polarized in the YZ 620 plane and the other in the XY plane 610. If the waves reach their maximum and minimum points at the same time, their vector sum leads to one wave, linearly polarized at 45 degrees. Similarly, if the two waves are 180 degrees out of phase, the resultant is linearly polarized at 45 degrees in the opposite sense (not shown).

The effect of using polarized light is that the linear polarizer at the receiver, substantially screens out light that is not in the same plane as the linearly polarized signal from the transmitter. This increases the signal to noise ratio, the non-signal light considered to be noise. Additionally, the polarizer allows the use of a less sensitive receiver, resulting in a cost savings.

In another embodiment, the linear polarizers transmit and receive the signal over an angular range, for example thirty degrees. The effect of transmitting and receiving the signal over an angular range is to decrease the likelihood that the respective polarizers are out of alignment, which causes a lack of signal reception at the receiver. Figure 7A, illustrates a signal 710 created from a linear polarizer at the transmitter, where the signal lies on a linear vertical plane, a user who has tilted his head to the left 720, and the corresponding orientation of the linear polarizer 730 at the receiver. The angled orientation of the receiver polarizer 730, causes the polarizer at the receiver, and the polarizer at the transmitter to be out of alignment. This results in much signal being lost and not received by the receiver.

Figure 7B, illustrates where a polarizer is designed to receive a signal at a range of angles 740. The transmitter emits a linearly polarized signal 710 that lies in the vertical plane. As the user angles his head 720, the polarizer 740 at the receiver, stays in alignment with the polarizer at the transmitter, because no part of the signal 710 lies outside the area covered by the polarizer 740 at the receiver. Thus, because the receiver is able to fully receive the incoming signal, there is no signal loss.

In another preferred embodiment, a filter is used to filter out frequencies of light that are not in the infrared range. A film coating is applied to the receiver that allows infrared light to pass through, but absorbs or reflects light of other frequencies.

In another embodiment, a computing element, at the receiver, samples the whole signal and filters out frequencies that do lie in the infrared spectrum. As can be seen if Figure 8, the infrared spectrum occupies a certain range of frequencies. Those frequencies that are higher 820 and lower 830 are filtered out. The result is an infrared signal that has a higher signal to noise ratio than an unfiltered signal.

Figures 9A, 9B and 9C illustrate another embodiment of the invention where a counterweight 910 is attached to the receiver 900, such that the receiving portion 930 always lies substantially orientated in the same way. Figure 9A illustrates a side view of the receiver 900, where the receiver 900 consists of a receiving portion 930, protruding from a contoured container 940. The receiver portion 930 is rotatably contained in the contoured container 940, and is attached to the container at a central point 950.

Figure 9B illustrates a frontal view of the receiver, where the receiver portion 930 of the receiver lies in a slot 960 in the container 940 so that the receiver portion 930 can freely rotate without the container interfering with the rotation of the receiver portion. The counterweight 910 is adapted with the receiver 900, so that as the orientation of the receiver 900 changes, the receiver portion 930 rotates relative to the container 940 such that the receiving portion 930 remains substantially orientated the same.

The counterweight does this by effectively moving the center of gravity of the receiver away from the volumetric center of gravity. As the receiver is shifted, the receiver portion rotates around the centrally hinged position 950, such that the receiver 900 returns to its original position, to maintain static and dynamic

equilibrium. Figure 9C illustrates another embodiment where the counter-weight 970 is designed to keep the receiving portion 930 directed in an upward direction.

Figures 10A, 10B, and 10C illustrate another preferred embodiment of the invention where an array of transmitters are used. At least one transmitter is aimed such a way that the infrared signal is incident upon a receiver along a direct path, while the other transmitters 1010, 1020, 1030 are aimed to have their signal 1012, 1022, 1032 to be received by a receiver 1000 after reflecting off of an object, such as, a ceiling 1011, floor 1021 or wall 1031. It is also contemplated that the signal may reflect off of objects such as furniture, statues, wall hanging, and even family pets.

Figure 11 illustrates another preferred embodiment where a parabolic deflector 1100 is combined with a receiver 1120, to increase the amount of signal received. The conical deflector is attached to a frontal portion of a receiver 1120. The interior of the deflector has high reflective qualities, causing an incident infrared signal 1140 to reflect off of its surface. The conical shape of the deflector causes a reflected signal 1130 to be incident

upon the receiver 1120. It is contemplated that the deflector is adjustable to maximize the signal reflection.

In another embodiment of the invention, the infrared transmitter and receiver are used to transmit data across a distance. For example, a transmitter/receiver combination can be used for connecting with cable Internet. A typical Internet cable connection has a wire lead passing from the exterior of the home, through a hole in the wall, to an external network card that is connected to the computer. Using the transmitter/receiver combination, the cable passes through the hole in the wall, and in close proximity to the wall, plugs into the transmitter, which transmits a data signal. The receiver is integrated with the external modem, and receives the Internet signal from the transmitter, and the signal is transmitted from the network card to the computer.

Figure 12 illustrates another preferred embodiment where, an infrared receiver 1210, 1211 is combined with self-amplified, wireless speakers 1220, 1221. The speakers 1220, 1221 receive an input signal 1230 from an infrared transmitter 1205. The speakers can be used to produce stereo or surround

sound. The speakers 1220, 1221 are placed in locations within the listening environment such that they produce an enjoyable listening experience.

When used as surround sound speakers, the television's speakers are used to produce front and/or center channel sound. Figure 13 illustrates a sound encoder 1310 that lies in line between the input television signal producer 1320, and the television 1330. The encoder 1310 processes the input stereo signal 1321 and directs front and center channel signals 1331 to the television 1330, and sends a surround sound signal 1341 to the transmitter 1340, which is then sent to the wireless speakers. Surround sound is produced from a stereo input signal by delaying the signal, so as to produce a spatial effect. Also, the surround sound volume level is typically lower than the front and center channels.

In another embodiment, a decoder processes a multi-channel surround encoded signal. The decoder directs front and center channel signals to the television, and surround sound signals to the transmitter.

Although the invention is described herein with reference to the preferred embodiment, one skilled in the art will readily appreciate that other

applications may be substituted for those set forth herein without departing from the spirit and scope of the present invention. Accordingly, the invention should only be limited by the claims included below.